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NYLON/GRAFTED POLYOLEFIN RELEASE FILM FOR SHEET MOULDING COMPOUND

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(57) Claim

1. A release film made from a blend comprising from 5 to 25 wt.% of a C₂-C₂₀ alpha-olefin polymer grafted with an ethylenically unsaturated hydrocarbon with at least one functional group, and from 95 to 75 wt.% of an aliphatic polyamide, the melt viscosities of said polyamide and graft polyolefin being selected such that the blend is homogeneous.

10. A film according to Claim 1 wherein the grafted alpha-olefin polymer is grafted with a grafting monomer selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, crotonic acid, 5-norbornene-2,3 dicarboxylic acid, methyl-5-norbornene-2,3dicarboxylic acid, maleic anhydride, dimethylmaleic anhydride, monosodium maleate, disodium maleate, acrylamide, itaconic anhydride, citraconic anhydride, maleimide, N-phenylmaleimide, diethyl fumarate, vinyl pyridines, vinyl silanes, 4-vinyl pyridine, vinyltrioxysilane and allyl alcohol.

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Complete Specification for the invention entitled:
NYLON/GRAFTED POLYOLEFIN RELEASE FILM FOR
SHEET MOULDING COMPOUND.

The following statement is a full description of this invention
including the best method of performing it known to me:-

NYLON/GRAFTED POLYOLEFIN RELEASE
FILM FOR SHEET MOULDING COMPOUND

The present invention relates to a release film for sheet moulding compound, and in particular a film 5 made from a blend of nylon and a grafted polyolefin.

Sheet moulding compound, often known as SMC, is used in the manufacture of shaped articles such as body parts for cars, e.g. body panels, bumpers and fenders, body parts for boats, housings for electric 10 and electronic components, e.g. housings for personal computers, switch boxes and the like. Sheet moulding compound generally comprises a crosslinkable polyester resin containing fibre reinforcement, e.g. glass fibres. The sheet moulding compound is usually 15 manufactured by depositing the fibres onto a layer of uncrosslinked polyester resin which is supported on a moving support bed, e.g. a polyethylene or nylon film. Another film is placed on top of the resin/fibre composite to form a sandwich of the 20 composite between two films. The sandwich is then passed through a series of rollers whose function is to knead the fibre and resin and cause thorough mixing of the fibre and resin. The sandwich is then wound up on rolls or cut to conveniently sized pieces 25 and stored at ambient temperature ready for further processing. During the storage period the polyester resin partially crosslinks, causing an increase in the viscosity of the sheet moulding compound, until

the compound is at a mouldable consistency. The users of the sandwich, i.e. moulders, cut a suitable length of the sandwich from a roll, strip the film from the sheet moulding compound prior to placing the sheet moulding compound in a suitably shaped mould, and then apply pressure and heat to achieve a full 5 "cure", i.e. to fully crosslink, the polyester resin thermoset material. It is desirable that the films, which are usually known as release films, strip from the sheet moulding compound cleanly.

Two properties in particular are of importance 10 to manufacturers and users of sheet moulding compound. The first is that of styrene permeability of the release film. It is desirable that the release film has sufficiently low styrene permeability to prevent undue loss of styrene 15 monomer, which acts as a crosslinking agent for the polyester, from the sandwich. The second is that the release film should be easily peelable from the sheet moulding compound.

As indicated hereinabove polyethylene has been 20 used as a release film for sheet moulding compound. Although the release characteristics of polyethylene are good enough for automated stripping operations, it has poor styrene permeability properties and rolls of sheet moulding compound are usually also wrapped 25 in aluminium foil or a nylon film to prevent loss of styrene monomer.

In U.S. Patent 4 444 829, which issued 1984 April 24 to Bollen, Degrassi and Sacks, there is described a low crystallinity polyamide film 30 comprising a blend of 90 to 70 wt.% of a polyamide having a crystallinity of less than 35% and 10 to 30 wt.% of a polyolefin component. The polyolefin

component, which is a linear high molecular weight polymer of alpha-olefins, copolymer of alpha-olefin and vinyl acetate monomers or an alkyl acrylate, has a crystallinity of less than 50%. The film thickness is from about 12.7 to 5 127 μm , has a Graves tear strength of at least about 400 g in the longitudinal direction and a styrene permeability of below about 200×10^{-9} g.cm/ $\text{cm}^2\text{.h}$.

Some commercially available polyamide release films, while having sufficiently good styrene permeability 10 characteristics, tend to have release properties which, while suited to manual stripping operations, are less suited for automated stripping operations. In manual stripping operations care must be exercised to ensure that the release film strips cleanly away from the sheet 15 moulding compound and to ensure that the release film does not rip. The present invention provides alternatives to the currently-used commercial polyamide-based release films and, in some instances provides release films which are more suited for use in automated stripping operations.

20 The present invention provides a release film made from a blend comprising from 5 to 25 wt.% of a $\text{C}_2\text{-C}_{20}$ alpha-olefin polymer grafted with an ethylenically unsaturated hydrocarbon with at least one functional group, and from 95 to 75 wt.% of an aliphatic polyamide, the melt 25 viscosities of said polyamide and grafted copolymer being selected such that the blend is homogeneous.

In one embodiment the aliphatic polyamide is made from an aliphatic dicarboxylic acid and an aliphatic diamine, each having from 6 to 24 carbon atoms.



In another embodiment the aliphatic polyamide is made from an aliphatic aminoacid or lactam having from 6 to 24 carbon atoms.

5 In a further embodiment the aliphatic polyamide is made from a mixture of i) a polyamide made from an aliphatic dicarboxylic acid and an aliphatic diamine, each having from 6 to 24 carbon atoms and ii) a polyamide made from an aliphatic aminoacid or lactam having from 6 to 24 carbon atoms.

10 Particularly preferred polyamides are nylon 66, nylon 6 and mixtures thereof. For nylon 6 intrinsic viscosities (IV) in the range of 0.85 to 1.4 dl/g may be used. It is preferred that the intrinsic viscosity be in the range of 0.95 to 1.2 dl/g. Intrinsic viscosity is measured at 25°C in formic acid (85 wt.% acid to 15 wt.% water) by methods known 15 in the art. An especially preferred polyamide is nylon 66 having a relative viscosity (RV) in the range of 40 to 80, particularly 45 to 60. Relative viscosity is the ratio of viscosity at 25°C of an 8.4 wt.% solution of nylon in 90 wt.% formic acid (90 wt.% acid to 10 wt.% water) to the viscosity at 25°C of the 90 wt.% formic acid alone. The polyamide may 20 be a blend of polyamides, e.g. nylon 66 having a relative viscosity of 45 and nylon 66 having a 25 relative viscosity of 65. The polyamide may also be a blend of different polyamides, e.g. nylon 6 and nylon 66.

In another embodiment the grafted alpha-olefin copolymer is selected from the group consisting of grafted homopolymers of ethylene, grafted homopolymers of propylene, grafted homopolymers of butene-1, grafted copolymers of ethylene and a C₃ to C₁₀ alpha-olefin, grafted ethylene/propylene elastomers, grafted polystyrene, grafted copolymers of ethylene and acrylic acid, grafted copolymers of ethylene and methacrylic acid, grafted copolymers of ethylene and vinyl acetate, and grafted ionomeric polymers derived from copolymers of ethylene and acrylic acid or methacrylic acid.

In another embodiment the grafted alpha-olefin copolymer is a grafted copolymer of ethylene and/or propylene with at least one of butene-1, hexene-1, 4-methyl pentene-1 and octene-1.

In a preferred embodiment the grafted alpha-olefin polymer is grafted polypropylene.

In a particularly preferred embodiment the grafted alpha-olefin is grafted polypropylene, present in the release film in the amount of from 10 to 20 wt.%, and especially a grafted polypropylene having a melt index of from 15 to 30 dg/min.

In one embodiment the grafted alpha-olefin polymer is grafted with a grafting monomer selected from the group consisting of ethylenically unsaturated C₃-C₁₀ carboxylic acids, ethylenically unsaturated C₃-C₁₀ carboxylic acid anhydrides, derivatives of such acids or anhydrides, ethylenically unsaturated hydrocarbons with other functional groups, and mixtures thereof.

In a further embodiment the grafting monomer is selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic

acid, crotonic acid, 5-norbornene-2,3dicarboxylic acid, methyl-5-norbornene-2,3dicarboxylic acid, maleic anhydride, dimethylmaleic anhydride, monosodium maleate, disodium maleate, acrylamide, itaconic anhydride, citraconic anhydride, maleimide, N-phenylmaleimide, diethyl fumarate, vinyl pyridines, 5 vinyl silanes, 4-vinyl pyridine, vinyltriethoxysilane and allyl alcohol.

In yet another embodiment the grafting monomer consists of at least two grafting monomers wherein one of the grafting monomers is selected from the 10 group consisting of styrene, 2-methyl styrene, 4-methyl styrene, alpha-methyl styrene, beta-methyl styrene, 4-vinyl anisole, stilbene and indene, and mixtures thereof, and the other of the grafting monomers is selected from the group consisting of 15 maleic anhydride, itaconic anhydride, citraconic anhydride, maleimide and N-phenylmaleimide, and mixtures thereof.

In another embodiment the grafting monomer is present in the grafted polymer in an amount of from 20 0.05 to 2 wt.%.

In a preferred embodiment the grafting monomer is present in the graft polymer in an amount of from 0.05 to 0.5 wt.%.

In further embodiments the grafted alpha-olefin 25 copolymer has a melt index, as determined by the procedure of ASTM D-1238 (Condition E), of from 10 to 50 dg/min, especially from 15 to 30 dg/min.

A number of methods have been developed for 30 grafting monomers onto hydrocarbon polymers. For instance, the grafting of monomers onto molten

polymers is known, e.g. as described in U.S. 4 612 155 to C.S. Wong and R.A. Zelonka, which issued 1986 September 16. A process in which a mixture of styrene and maleic anhydride is formed and then reacted with a polymer having active hydrogen atoms at a temperature above about 120°C is disclosed
5 in Canadian Patent 907 248 of N.G. Gaylord, which issued 1972 August 08. A similar process is also disclosed by N.G. Gaylord et al. in Polymer Letters Vol. 10, pp 95-100 (1972). A process for modifying rheological or chemical and rheological properties of
10 a polymer in which monomers are grafted on to a polymer in an extruder is disclosed in Canadian Patent 993 592 of R.A. Steinkamp et al., which issued 1976 July 20.

15 The films of the present invention may be dyed with thermally stable nylon compatible dyes, e.g. FILAMID (trade mark) Yellow R dye, or pigmented with thermally stable nylon or graft polymer compatible pigments, e.g. titanium dioxide.

20 The invention may be illustrated by reference to the following examples:

Example I

25 Films from several compositions within the scope of the present invention were prepared. Granular polyamide resin was mixed with pellets of the grafted polyolefin and the mixture was then melt extruded and cast into film having a thickness of 25 μ m, using a Werner and Pfleiderer Corporation 53 mm twin screw extruder combined with a film forming die and a chill roll casting machine. In the case of those
30 compositions containing a pigment, the pigment was

either added in the form of a pigment-containing polyamide resin or in the form of a pigment containing-polyolefin. The films so formed were tested for release characteristics using an apparatus which was adapted to grasp the end of a 2.5 cm wide strip of film and to strip the film from a slab of sheet moulding compound at a constant rate of 1.5 cm/s. The apparatus was also adapted to determine the force required to strip the film. In the following table, the columns marked "Force" indicate the force required to strip the release film from the sheet moulding compound, expressed as a percentage of the force required to strip a commercially available release film, CAPRAN ER20 (trade mark) film which is believed to be made from a blend of nylon 6 and an ethylene/vinyl acetate copolymer, containing titanium dioxide. The accuracy of measurement of force is $\pm 10\%$.

Table 1

	Composition	SMC Paste	Force		% Grafted Polymer
			7 days	14 days	
20	1817-173-55	Appliance	80	95	3*
	1817-186-62	Appliance	25	30	12
	1817-173-52	Appliance	96	100	3.75*
	1817-186-64	Appliance	30	55	15
	1817-186-62	Automotive	50		12
25	1826-11-244	Appliance	30	15	15
	1826-11-244	Automotive	30	35	15
	1826-03-172	Appliance	30	25	15
	1826-03-174	Appliance	35	35	15
	1826-03-172	Automotive	45		15
30	1826-03-175	Appliance	30	35	15
	973-07-111	Appliance		50	17

Table 1 (cont'd)

Composition	SMC Paste	Force		% Grafted Polymer
		7 days	14 days	

973-07-124	Appliance	35	17
973-07-134	Appliance	45	17

5 * Outside the scope of the present invention;
included for reference only.

The specific compositions are as shown in
Table 2.

Table 2

Composition

10	1817-173-55	3% MAH-g-PE, 9% PP, 3% E/P
	1817-173-52	3.75% MAH-g-EP, 11.25% PP
	1817-186-62	12% MAH-g-PP1, 1% PE, 1% TiO ₂
	1817-186-64	15% MAH-g-PP1, 1% PE, 1% TiO ₂ 2%
15	1826-11-244	15% MAH-g-PP
	1826-03-172	15% MAH-g-PP, 1% PE, 1% TiO ₂
	1826-03-174	15% MAH-g-PP, 1% PE, 1% TiO ₂
	1826-03-175	15% MAH-g-PP, 1% PE, 1% TiO ₂
	973-07-111	17% MAH-g-PP, 2.5% PE, 0.84% TiO ₂
20	973-07-124	17% MAH-g-PP, 2.5% PE, 0.84% TiO ₂
	973-07-134	17% MAH-g-PP, 2.5% PE, 0.84% TiO ₂
	the remainder of the compositions consisting of nylon 66 having an RV of 52 wherein:	
	PE is low density polyethylene used as a carrier for TiO ₂ ;	
25	PP is SHELL GE 6100 (trade mark) polypropylene homopolymer;	
	E/P is PROFAX 7701 (trade mark) ethylene/propylene copolymer;	
	MAH-g-EP is PROFAX 7701 ethylene/propylene copolymer grafted with 0.08 % maleic anhydride;	

MAH-g-PE is SCLAIR 19C (trade mark)
polyethylene grafted with 1.0 wt.% maleic
anhydride (a 80:20
blend of E/P:g-PE has a melt index of 1.3);
MAH-g-PP is SHELL GE 6100 polypropylene grafted
with 0.14 wt.% maleic anhydride, the grafted
5 polymer having a melt flow index of 30;
MAH-g-PP1 is SHELL GE 6100 polypropylene
grafted with 0.14 wt.% maleic anhydride, the
grafted polymer having a melt flow index of 42;
and TiO_2 is titanium dioxide.

10 For comparative purposes an attempt was
made to form a film from nylon 66 and 17 wt.%
ungrafted polypropylene having a melt flow
index of 16-24 and 0.1 wt.% FILAMID yellow dye,
using methods similar to that for the other
15 films hereinabove. The film had very poor
physical integrity and was not useful as a
release film.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A release film made from a blend comprising from 5 to 25 wt.% of a C₂-C₂₀ alpha-olefin polymer grafted with an ethylenically unsaturated hydrocarbon with at least one functional group, and from 95 to 75 wt.% of an aliphatic polyamide, the melt viscosities of said polyamide and graft polyolefin being selected such that the blend is homogeneous.
2. A film according to Claim 1 wherein the aliphatic polyamide is made from an aliphatic dicarboxylic acid and an aliphatic diamine, each having from 6 to 24 carbon atoms.
3. A film according to Claim 1 wherein the aliphatic polyamide is made from an aliphatic aminoacid or lactam having from 6 to 24 carbon atoms.
4. A film according to Claim 1 wherein the aliphatic polyamide is made from a mixture of i) a polyamide made from an aliphatic dicarboxylic acid and an aliphatic diamine, each having from 6 to 24 carbon atoms and ii) a polyamide made from an aliphatic aminoacid or lactam having from 6 to 24 carbon atoms.
5. A film according to Claim 1 wherein the aliphatic polyamide is selected from the group consisting of nylon 66, nylon 6 and mixtures thereof.
- 25 6. A film according to Claim 5 wherein the nylon is nylon 66 having a relative viscosity of from 40 to 80.
7. A film according to Claim 5 wherein the nylon is nylon 66 having a relative viscosity of from 45 to 60.

8. A film according to Claim 5 wherein the nylon is nylon 6 having an intrinsic viscosity of from 0.85 to 1.4 dl/g.

9. A film according to Claim 5 wherein the nylon is nylon 6 having an intrinsic viscosity of from 0.95 to 1.2 dl/g.

5 10. A film according to Claim 1 wherein the grafted alpha-olefin polymer is grafted with a grafting monomer selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, crotonic acid, 5-norbornene-2,3 dicarboxylic acid, methyl-5-norbornene-2,3dicarboxylic acid, maleic anhydride, dimethylmaleic anhydride, monosodium maleate, disodium maleate, acrylamide, itaconic anhydride, citraconic anhydride, maleimide, N-phenylmaleimide, diethyl fumarate, vinyl pyridines, vinyl silanes, 4-vinyl pyridine, vinyltriethoxysilane and allyl alcohol.

20 11. A film according to Claim 10 wherein the grafted alpha-olefin polymer is selected from the group consisting of grafted homopolymers of ethylene, grafted homopolymers of propylene, grafted ethylene/C₃ to C₁₀ alpha-olefin copolymers and grafted ethylene/vinyl acetate copolymers.

25 12. A film according to Claim 10 wherein the the grafting monomer is maleic acid, maleic anhydride or fumaric acid.

30 13. A film according to Claim 11 wherein the grafting monomer is maleic acid, maleic anhydride or fumaric acid.

35 14. A film according to Claim 10 wherein the the grafting monomer consists of at least two grafting monomers wherein one of the

grafting monomers is selected from the group consisting of styrene, 2-methyl styrene, 4-methyl styrene, alpha-methyl styrene, beta-methyl styrene, 4-vinyl anisole, stilbene and indene, and mixtures thereof, and the other of the grafting monomers is selected from the 5 group consisting of maleic anhydride, itaconic anhydride, citraconic anhydride, maleimide and N-phenylmaleimide, and mixtures thereof.

15. A film according to Claim 11 wherein the the grafting monomer consists of at least 10 two grafting monomers wherein one of the grafting monomers is selected from the group consisting of styrene, 2-methyl styrene, 4-methyl styrene, alpha-methyl styrene, beta-methyl styrene, 4-vinyl anisole, stilbene and indene, and mixtures thereof, and the other 15 of the grafting monomers is selected from the group consisting of maleic anhydride, itaconic anhydride, citraconic anhydride, maleimide and N-phenylmaleimide, and mixtures thereof.

20. A film according to any one of Claims 12 to 15 wherein the the grafting monomer is present in the graft polymer in an amount of from 0.05 to 2 wt.-%.

25. A film according to any one of Claims 12 to 15 wherein the the grafting monomer is present in the graft polymer in an amount of from 0.05 to 0.5 wt.-%.

30. A film according to Claim 1 wherein the grafted alpha-olefin polymer is a grafted copolymer of ethylene and/or propylene with at least one of butene-1, hexene-1, 4-methyl pentene-1 and octene-1.

35. A film according to Claim 11 wherein the grafted alpha-olefin copolymer is grafted

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polypropylene, present in the release film in
the amount of from 10 to 20 wt.-%.

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DATED THIS 21ST DAY OF NOVEMBER 1989

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Attorneys of Australia.

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